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How to ensure traceability by means of a transfer instrument ?

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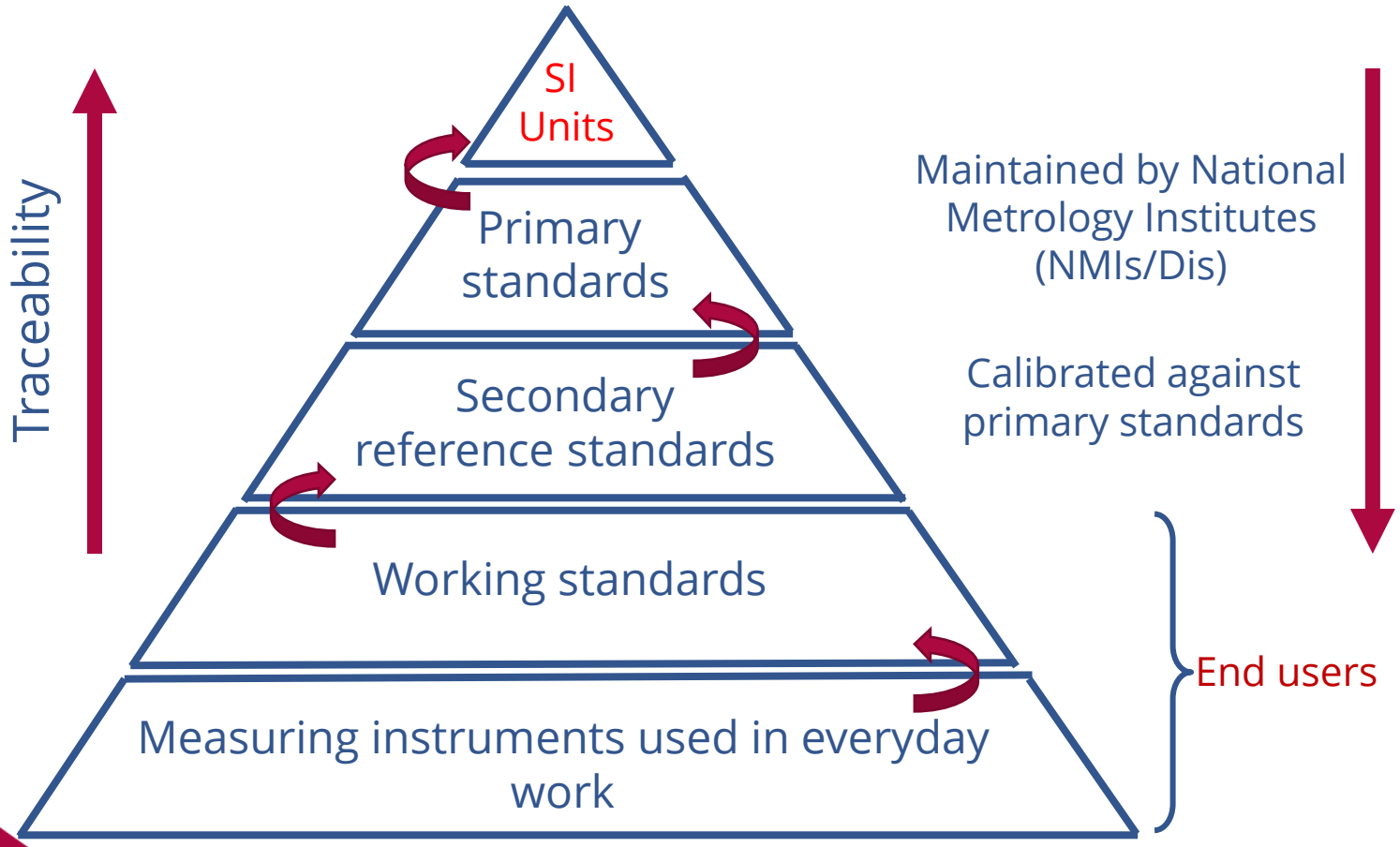
What is traceability ?



International vocabulary of metrology – Basic and general concepts and associated terms (VIM) – JCGM 200/2012

2.41 (6.10)
metrological traceability
property of a **measurement result** whereby the result can be related to a reference through a documented unbroken chain of **calibrations**, each contributing to the **measurement uncertainty**

2.42 (6.10 Note 2)
metrological traceability chain
traceability chain
sequence of **measurement standards** and **calibrations** that is used to relate a **measurement result** to a reference

2.43
metrological traceability to a measurement unit
metrological traceability to a unit
metrological traceability where the reference is the definition of a **measurement unit** through its practical realization

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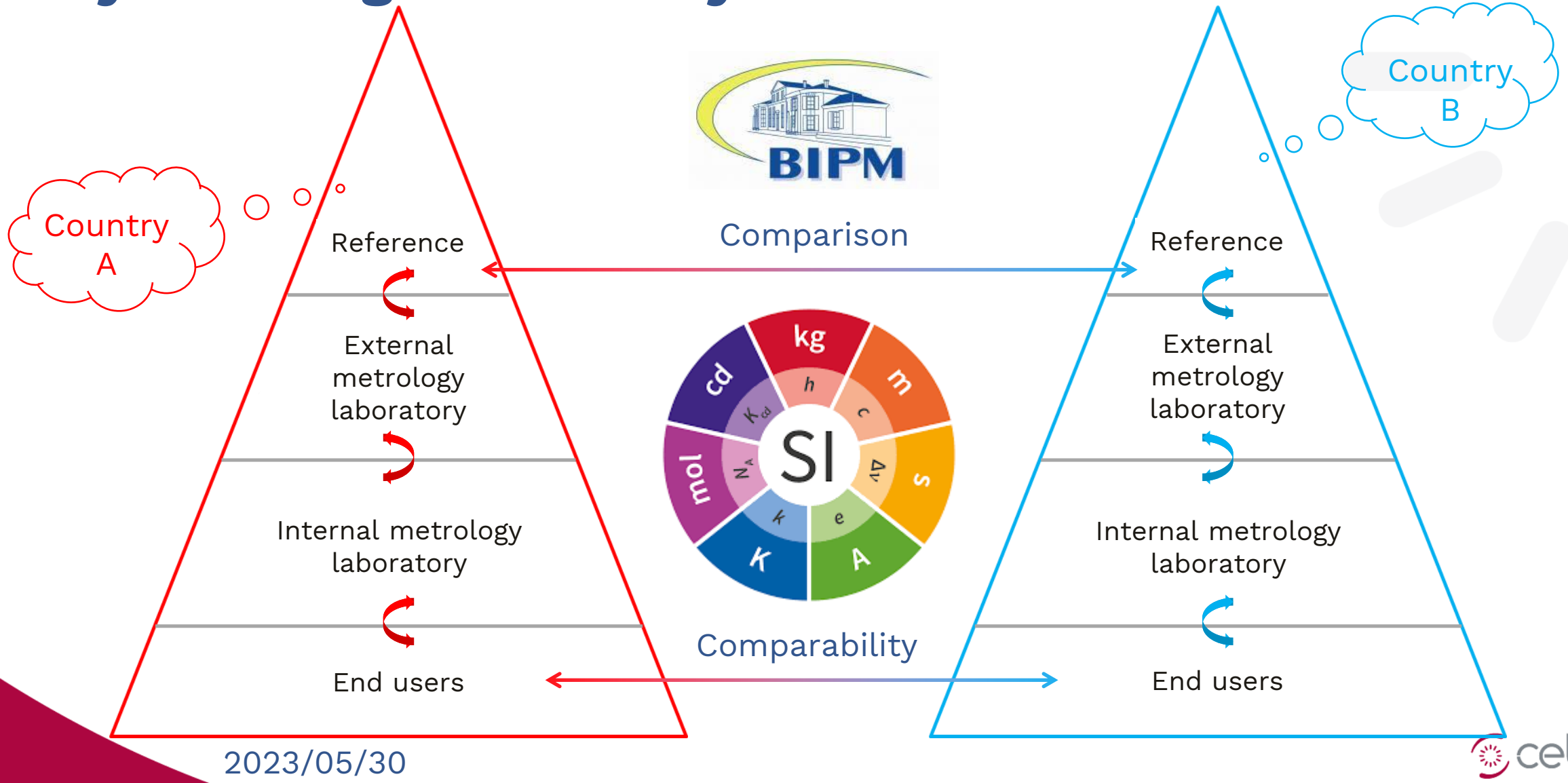
Why ensuring traceability ?



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Example of industrial application (1/12)

VERDO

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Example of industrial application (2/12)

VERDO

Capacity:
Electricity: 54 MW
District Heating: 145 MW

Production (average 2019-2020):
Electricity: 155.000 MWh/year
District Heating: 570.000 MWh/year

Fuel consumption: (2019)
Wood chips: 180.000 ton/year
Other biomass: 25.000 ton/year
Coal: 399 ton/year
Landfill gas: 279.000 Nm3/year

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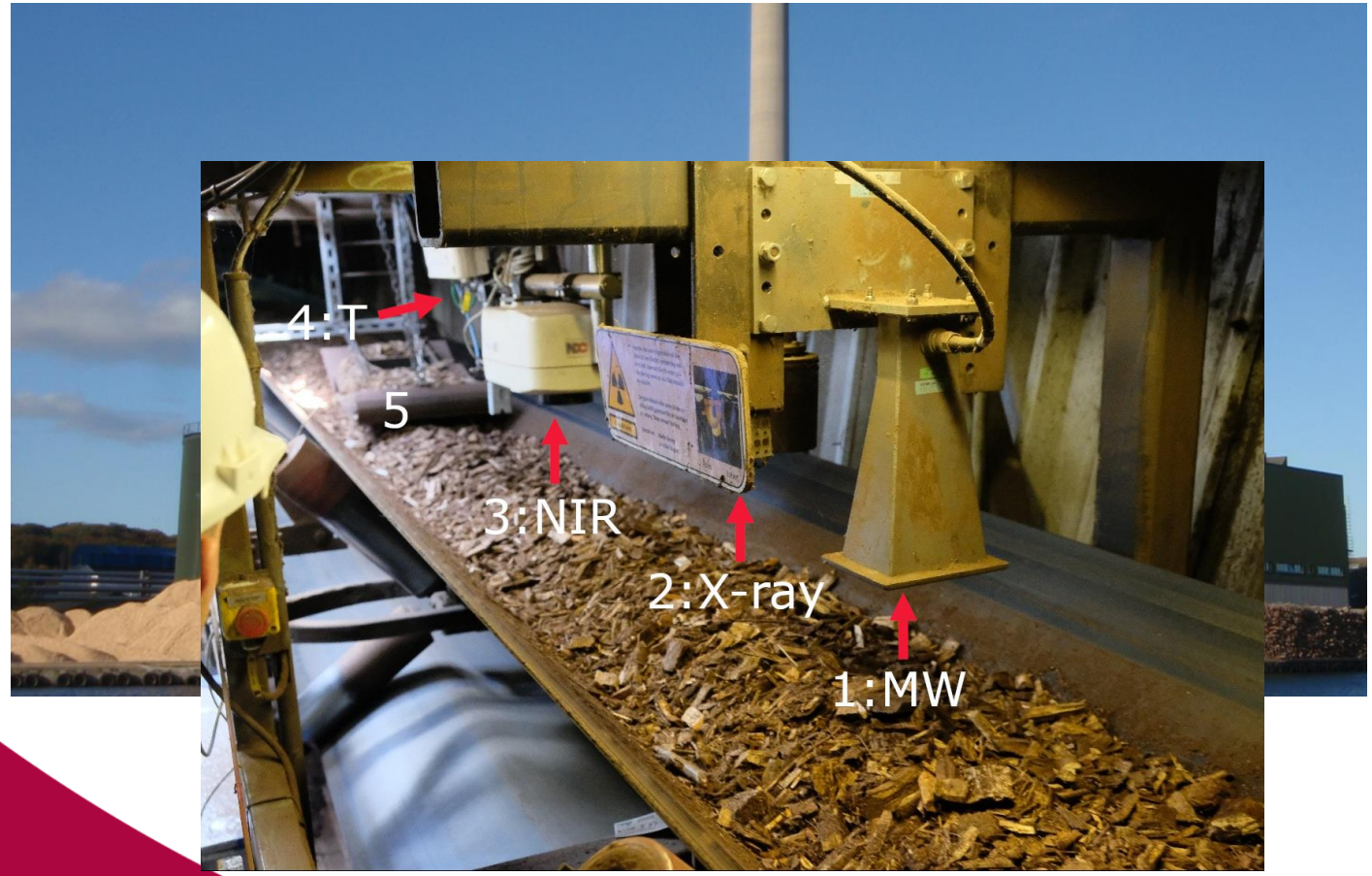
Example of industrial application (3/12)

VERDO



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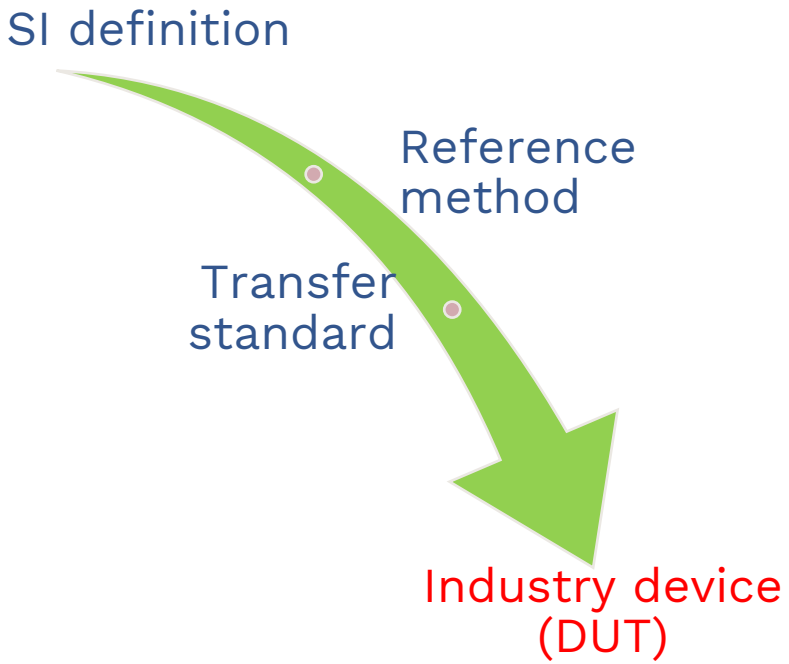
Example of industrial application (4/12)



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Example of industrial application (5/12)

Selected material

> "White" woodchips, no bark etc.
> Small chips packing
> Mixture of Picea Abies (Norway Spruce) and Picea Sitchensis (Sitka Spruce).

Water mass fraction 10 % to 60 %

> Pre-dried at 40 °C to 10 % water fraction
> Mixed …
> Re-humidified (12 fractions)

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Example of industrial application (6/12)

Traceability route n°1

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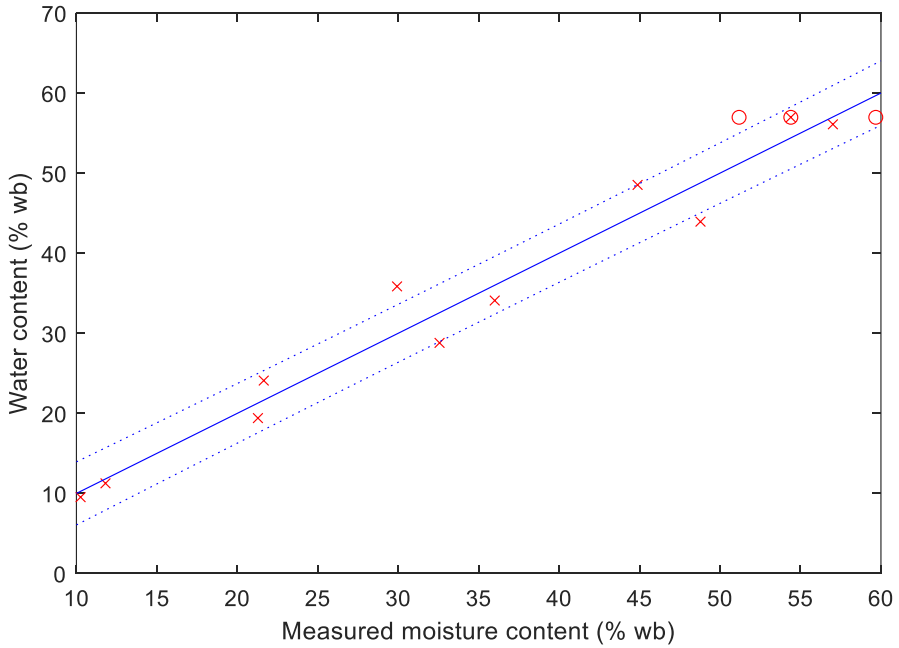
Example of industrial application (7/12)

Traceability route n°1



$$M = a \cdot \frac{phaseshift}{load} + b \cdot \frac{attenuation}{load} + c$$

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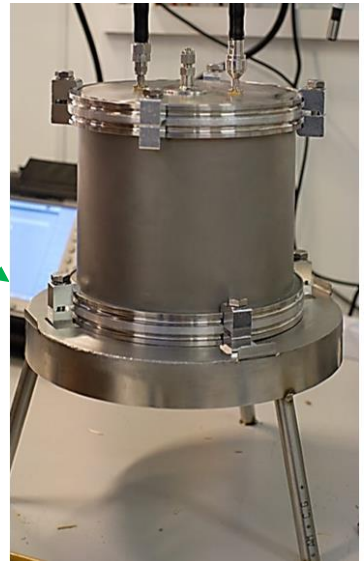
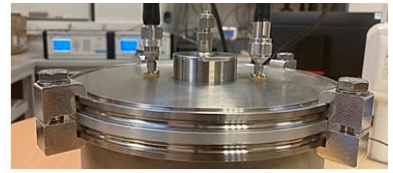
Example of industrial application (8/12)

Traceability route n°2





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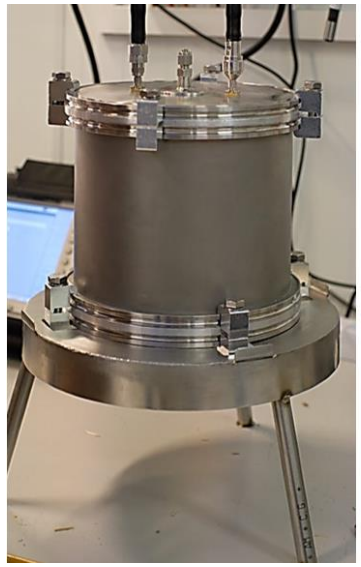
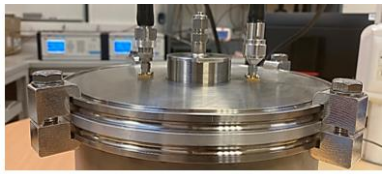
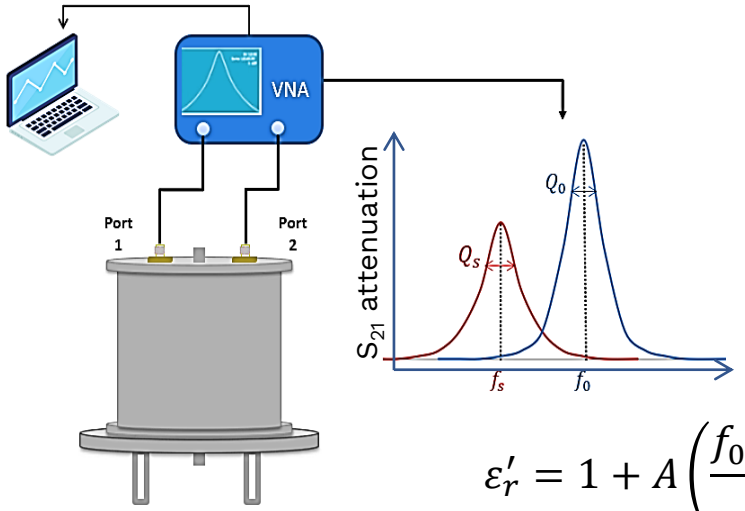
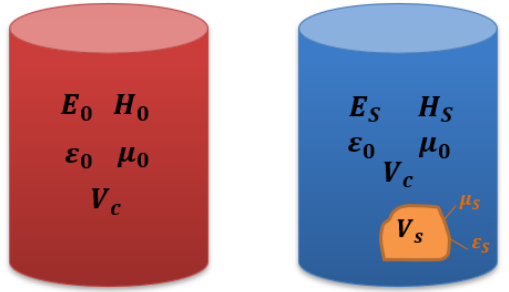
Example of industrial application (9/12)

Transfer instrument

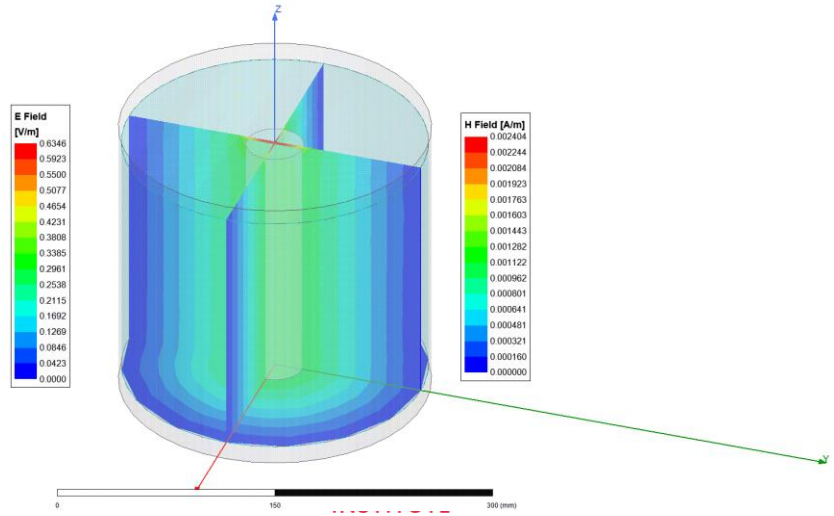








$$\varepsilon_r' = 1 + A\left(\frac{f_0 - f_s}{f_s}\right) \quad \varepsilon_r'' = B\left(\frac{1}{Q_s} - \frac{1}{Q_0}\right)$$



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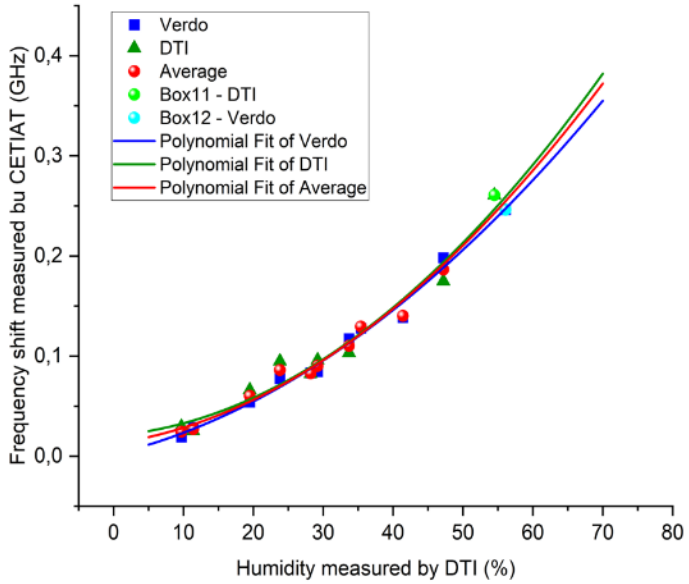
Example of industrial application (10/12)

Traceability route n°2



Equation	y = Intercept + B1*x^1 + B2*x^2		
Plot	Verdo	DTI	Average
Intercept	0,0018 ± 0,0118	0,0206 ± 0,0240	0,0125 ± 0,0153
B1	0,0017 ± 7,9964E-4	5,7607E-4 ± 0,0017	0,0010 ± 0,0010
B2	4,80E-5 ± 1,22E-5	6,55E-5 ± 2,62E-5	5,90E-5 ± 1,49E-5
Residual Sum of Squares	5,5299E-4	0,0015	0,00108
R-Square (COD)	0,9884	0,9658	0,9836
Adj. R-Square	0,9855	0,9544	0,9799

Box Nr.	Reference value (DTI) (%)	Estimated value from curve (%)
11	54,5	57,97
12	56,1	55,93

Box Nr.	Reference value (DTI) (%)	Estimated value from curve (%)
11	54,5	56,30
12	56,1	54,45

Box Nr.	Reference value (DTI) (%)	Estimated value from curve (%)
11	54,5	56,89
12	56,1	54,97

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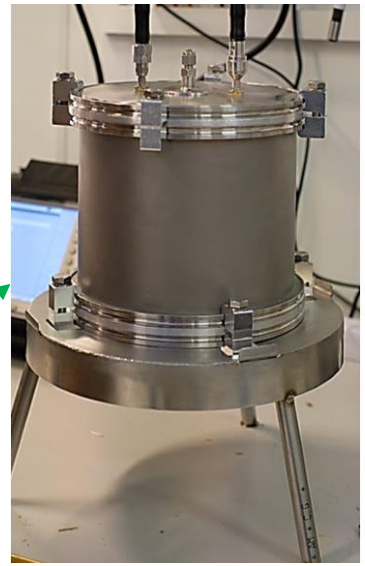
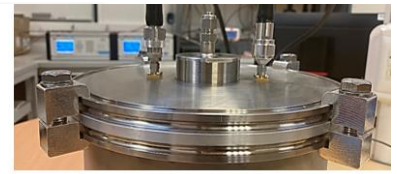
Example of industrial application (11/12)

Traceability route n°2





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Example of industrial application (12/12)

Traceability route n°2

$$M = a \cdot \frac{phaseshift}{load} + b \cdot \frac{attenuation}{load} + c$$

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Conclusion

Traceable moisture measurements rely on calibration

Demonstration with an industrial application

2 traceability routes using prepared material:

- reference method
- transfer standard

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Thank you for your attention !

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